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ASSESSMENT OF WORK-SPACE AND WORK-METHOD DESIGNS IN NIGERIA AUTOMOBILE SERVICE AND REPAIR INDUSTRY

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ABSTRACT

Nigeria automobile service industry is labour intensive with high level of work-related injuries among its workforce. This research assessed work-space (WsD) and work-method designs (WmD), level of compliance with recommended standards (RSs) and effects on workers' wellbeing. Clearances for services in 55 supine positions and 45 stand-up workbenches' (SUWb) heights were measured and compared with RSs. Questionnaires were completed among 252 workers to measure prevalence of work-related injuries. Descriptive statistical procedure and Chi-Square tests were conducted using SPSS. 94.4% of workers suffered from low back, 43.5% neck and 40% knees pains among others. Averagely, 43.33±7.3cm and 67±0.15cm were measured for supine position clearance and SUWb heights with 15.03±14.3 and 26.55±16.23 percentage deviations respectively from the minimum RSs. Automotive mechanics may be prone to back, hand and/or wrist related problems and Cumulative Trauma Disorders. Ergonomics trainings, use of mechanical devices and protective equipment will reduce injuries connected with the job.

Keywords: *automobile, workspace, supine, injuries, workbenches*

1. INTRODUCTION

Automotive mechanic is responsible for full range of automotive services needed to keep vehicles in good running condition. Manual handling related injuries however are common in automotive workshops across nations. This injury trend occurs across all types of vehicle repair, maintenance or installation work. The sector has one of the worst claims rates in the trade sectors. Each year, one in every fourteen workplaces lodges claims for serious injuries. Mostly reported are back and body stressing injuries (sprains and strains) which occurred from handling heavy lifting, and prolonged or sustained work in awkward postures [1].

In Nigeria, automotive sector was identified as a strategic industry group due to its large domestic market and labour intensive characteristics [2]. It was reported by [3] that most of the automobile workshops in Nigeria don't have any safety precautions in place to protect their workers who are also very ignorant of possible actions that can lead to injuries in their various auto workshops. Similar to the result from the developed countries, workers in Nigeria automobile services and repair industries often manually handle heavy vehicle parts and work in awkward postures leading to some medical conditions which affect the wellbeing of the workers [4]. In a study which assessed pattern of occupational health hazards among automobile mechanics in North West Nigeria, the commonest injuries were burns, bruises, crushed digits and cuts. Other reported injuries are low backaches, joint pains, and hernia [5].

As reported by [6], proper workspace design positively affects the attitude of workers and increases their productivity. When workers perform tasks in an unsafe and unhealthy workspace they are prone to occupational diseases [7]. In motor mechanics workshops, supine position and workbenches are commonly used to carry out repair works. Proper design of such workstations is necessary. According to [8], when work is to be done through limited spaces, appropriate clearances should be ensured. For supine

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work space a clearance between 51cm - 66 cm is recommended. Automobile workspace design should also allow routine, frequent, and/or short-term maintenance to be performed from a standing position using workbenches to reduce back strain. It was therefore recommended that workbench dimension for standing positions should conform to a desk surface height between 91.4cm-101.6 cm above floor and length as required by tasks.

This study is an extended ergonomics assessment into automobile mechanics job in the South-western part of Nigeria. The following research questions are raised to assist the research:

1. What level of prevalence is job related injuries among the group of workers and what parts of the body are mostly affected?
2. What are the risk factors, and are they statistically, contributing to the prevailing disorder(s)?
3. Do the common workspace and workstation designs comply with the recommended standard(s) (RSs*)*?
4. What measure(s) do workers and managers adopt in handling work related injuries?

1.1 Hypothesis

H_0: There is no significant association between the accessed work related hazards' risk factors and occurrence of an injury type base on the presenting problem of the workers.

2. MATERIALS AND METHODS

Observation method was used to assess job demands and workspace design. Techniques at which workers performed their tasks were followed. Among conditions checked included; physical conditions at work, biomechanical risk factors such as work repetition, work postures and load lifting. Observation method has lead to some of the most important scientific discoveries in human history. It involves engagement of brains as well as eyes and ears, organizing data so that sense can be made of them [9].

2.1 Workspace/Workstation Assessment And Measurements

Working beneath vehicle is often required to check for faults, servicing, repairs etc. These tasks are so common among motor mechanics [10]. As workers adopted supine positions, available clearance (cm) between floor and the point of work beneath vehicle was measured for 55 workers with a meter rule. 45 stand-up workbenches' heights (cm) were equally assessed and measured using a meter rule. These measurement values were compared with RSs from literatures and as reported by USDE [8].

2.2 Semi-Structured Interviews:

Questionnaires were completed among 252 workers through interviews with the use of a modified version of Nordic questionnaire as reported by [11] to measure subjective injury (past or present) on their different body regions by written response. This was to assess the type and degree of injuries among the workers. All potential volunteers agreed, and consents were taken in written form to have the interview conducted after they were informed that their participation was voluntary. The purpose of the study and the confidentiality of the information provided were emphasized. The interview lasted approximately 15 minutes for each subject.

2.3 Data Analysis

Descriptive statistical procedure and Non-parametric Chi-Square tests were conducted to analyse the recorded data using SPSS version 16.0. Descriptive statistics is the discipline of qualitatively description of the main features of a collection of information or the quantitative description itself. It allows the researcher to describe the data and examine relationships between two (or more) nominal-level variables [12, 13]. The Chi-Square results determined whether to accept or reject null hypothesis. When the test result showed $p<0.05$ then the null hypothesis was rejected, and the alternate was accepted which means there was no relationship among them. If however $p > 0.05$ then the null hypothesis was accepted which intends the association was not significant.

3. RESULTS AND DISCUSSION

3.1 Workers' Responses to Interviews:

Two hundred and fifty-two (90%) of the two hundred and eighty (280) workers that participated in the study completed the questionnaire. All subjects have spent not less than two (2) years on their current job. The demographics of the workers who participated in the studies are presented in Table 1. The average age of the workers is about 21 years most of which were 17 years of age and 6years on the current job.

Table 1: Statistic of the demographic information for workers studied in 12 automobile mechanic villages

Descriptions	Age	Years of Working Experience
Mean	21	3.5
Mode	17	6
Std. Deviation	5.1	0.7

3.2 Reported Work-Related Pains

One hundred and fifty two (152) respondents representing 60.3% reported one pain or the other in their body regions which lasted for 24 hours in the last 1 month. From Figure 1, almost all the workers involved in this study (94.4%) indicated suffering from low back pain. This is closely followed by pain in the neck region (43.5%) and pain in the knees (40%). Other reported pains included shoulder and wrist/hands (26.6%), hips/ thighs (25.8%) and fingers (19.4%).With 87.9% of the workers reported working more than 8 hours per day, 241 workers (95.6%) stated that their job required prolong time with rest period per day less than 1 hour. However 55.6% viewed their works as very excessive and dangerous.

3.3 Reported Health Conditions

About 86% of workers who reported discomforts in their various body parts do not visit hospital for work related pain treatment. Out of this group 65.3% reported lack of provision for health facility in their work place hence cannot afford hospital bills alone since their supervisors are not usually responsible. However, 49.2% of this category use local herbs while 50.8% engaged the use of various pain relievers as self treatment.

3.4 Risk Factors for Work Related Discomforts:

One hundred and ninety six (196) respondents (77.8%) stretched that their works involve forward bending and hand twisting (75.4%).

Two hundred and one (201) respondents (79.8%) stated that their work involves frequent lifting of automobile components and 156 (61.9%) reported standing for long period of time at work. 93.5 % of the workers work in uncomfortable postures for very long time daily while 98.4% said their jobs required forceful gripping of components and/or working tools (Figure 2). However 108 (87.1%) workers reported working with very good tools.

3.5 Test of Hypothesis

To examine the significance of association between assessed risk factors and the occurrence of injury type base on the presenting problem of the workers, non-parametric Chi-Square tests were performed. From Table 2, the result of statistical test for association between awkward postures and musculoskeletal pains in the low back regions shows a Chi Square value of 6.014 and p value of 0.014. The null hypothesis is rejected as a result and this means that there exist a relationship between the pains suffered by the workers in their low back region and awkward postures assumed while carrying out their job. Between forceful gripping and pain reported in the wrist/hands region, the Chi Square result value of 10.351 and p value of 0.001 lead to a rejection of null hypothesis implying that there is an association between forceful gripping of tools and/or automobile parts and musculoskeletal pain suffered by the reported workers in the wrist and/or hands regions.

Between working tools and pains in the fingers, Chi Square value of 21.909 and p value of 0.000 necessitated the rejection of null hypothesis which indicates that the association between the tools use by the workers and the various pain suffered in the fingers region is significant. Those who complained of emotional stress however could not be associated statistically with those going through musculoskeletal pains.

3.6 Workspace Assessment

Fifteen (15) selected cases from the entire (45) measured supine workspace clearance are presented in Table 3. The table also shows the minimum, and suited, RSs. On the average, 43.33±7.3 cm was recorded for supine workspace clearance with 34.34±11 and 15.03±14.3 percentage deviations from the suited and minimum RSs respectively.

Figure 3 shows a comparison for the measured supine work space clearances with the minimum, and suited, RSs values. As can be observed, no measured dimension well conformed to the suited RSs. Samples 4, 5 and 15 representing 20% were however above the minimum standards.

Five subjects (33.3%) out of the total can be considered closed to the minimum RSs while the rest (66.7%) deviated from the minimum values recommended. 45.5% highest deviations from suited

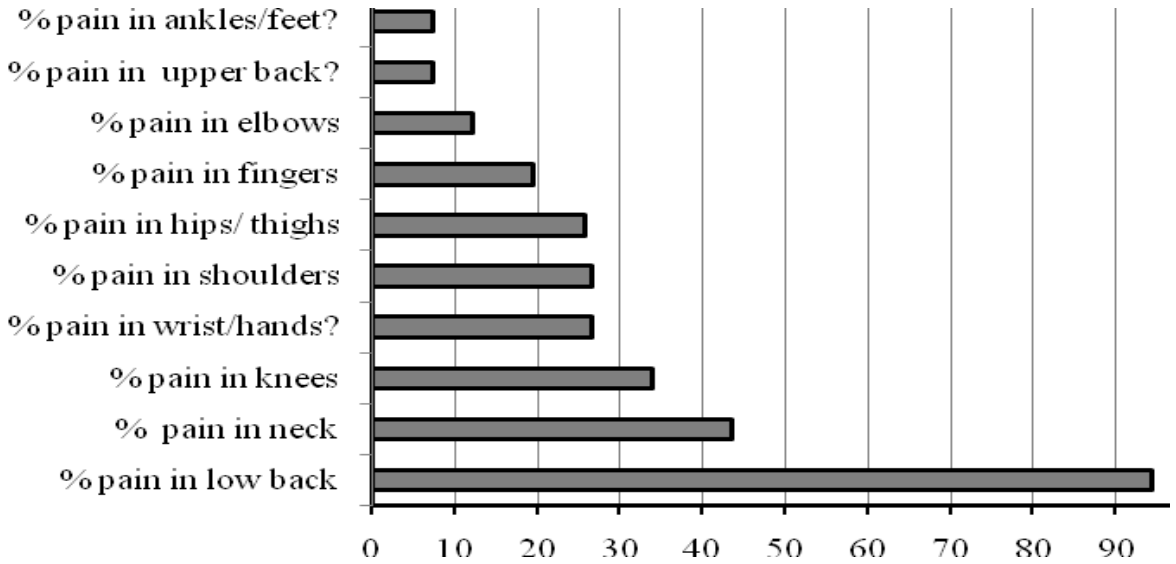

Figure 1: Percentages of respondents who reported pains in their body regions.

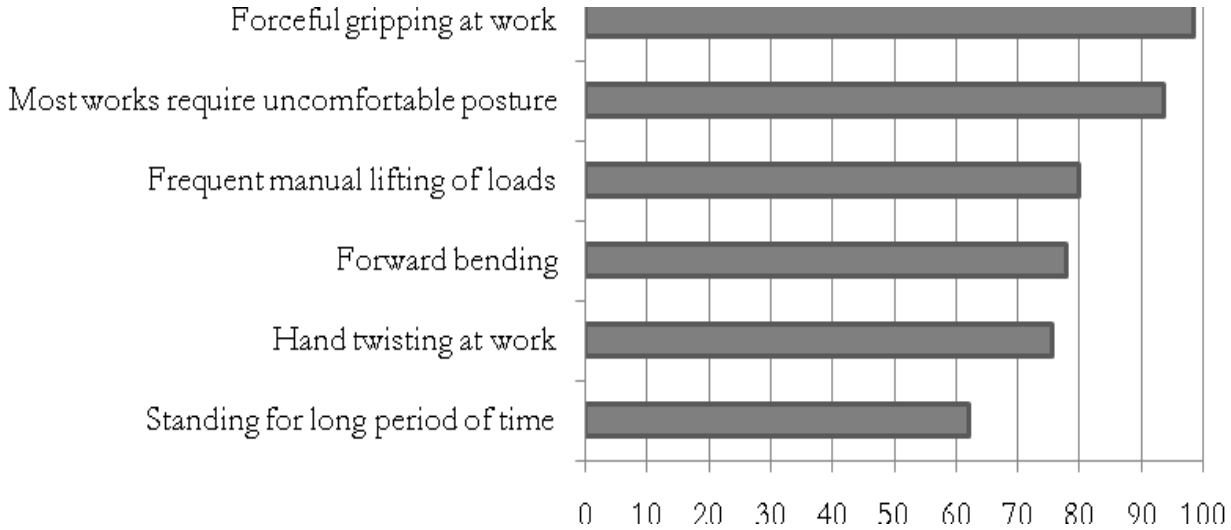

Figure 2: Percentages of Risk factors for work related discomforts

Table 2: Comparison of identified risk factors and the occurrence of injury type base on the presenting problem of the workers.

	Risk factors descriptions	Pearson Chi-Square		
		Value	Asymp. Sig. (2-sided)	Decision
1	Awkward postures and pain in the low back region	6.014	0.014	Significant
2	Forceful gripping and MS pain in wrist/hands region	10.351	0.001	Significant
3	Working tools and pain in the finger region	21.909	0 .000.	Significant
4	Emotional stress and pain experienced by workers	3.705	0.054	Not Significant
5	Forceful gripping and pain over thumb of wrist	7.015	0.021	Significant

*Table 3: Measured and the RSs dimensions for supine workspace with min RSs*and suited RSs* of 51 cm and 66 cm respectively*

Subject	Supine Work Space Dimensions		
	Measured (cm)	% Dev.From Suited	% Dev.From Min.
1.	44	33.3	13.7
2.	36	45.5	29.4
3.	37	43.9	27.5
4.	52	21.2	-2.0
5.	55	16.7	-7.8
6.	38	42.4	25.5
7.	37	43.9	27.5
8.	36	45.5	29.4
9.	51	22.7	0.0
10.	46	30.3	9.8
11.	37	43.9	27.5
12.	50	24.2	2.0
13.	39	40.9	23.5
14.	38	42.4	25.5
15.	54	18.2	-5.9
Average	43.33±7.3	34.34±11	15.03±14.3

**[8], RSs=Recommended Standards, Min.=Minimum, Dev.=Deviations*

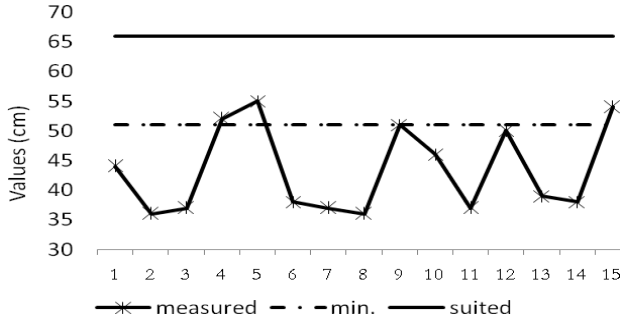

Figure 3: Comparisons between the measured supine work space clearances with the minimum, and suited, RSs

RSs among the groups was recorded for samples 2 and 5 while the same subjects recorded the highest deviation of 29.4% from the minimum RSs. From Table 4, average height of workbenches was 67±0.15 cm with 26.55±16.23 and 33.90±14.6 percentages deviations from minimum and maximum RSs for workbenches.

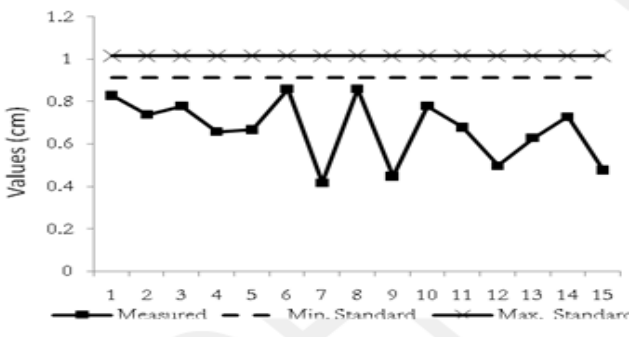

Figure 4: Comparisons between the measured workbench heights and the minimum and maximum RSs

Table 4: Measured and the recommended standards dimensions for Stand-up workbenches with Min. RSs and Max. RSs* of 91.4 cm and 101.6 cm respectively.*

Subjects	Stand-up workbenches		
	Measured (cm)	% Dev. From Min. RSs	% Dev. From Max. RSs
1	83	9.2	18.2
2	74	19.0	27.2
3	78	14.7	23.2
4	66	27.8	35.0
5	67	26.7	43.1
6	86	5.9	15.4
7	42	54.1	58.7
8	86	5.9	15.4
9	45	50.8	55.7
10	78	14.7	23.2
11	68	25.6	33.1
12	50	45.3	50.8
13	63	31.1	38.0
14	73	20.1	28.1
15	48	47.5	52.8
Average	67±0.15	26.55±16.2	33.90±14.6

**[8], RSs=Recommended Standards, Min.=Minimum, Max.=Maximum, Dev.=Deviations*

Plate 1: Worker lifting to fit 20kg tyre in awkward posture

Plate 2: Working with limited space under bonnet

Plate 3: Automobile mechanic working underneath at supine position

Plate 4: Automobile mechanic at kneeling position for a specific task

Plate 5; Automobile mechanic working beneath with limited clearance and awkward posture

Figure 4 compared 15 selected samples of the measured workbench dimensions for workspace necessitating standing positions. The minimum and maximum RSs design for stand-up benches for mechanical shop are also indicated. As can be observed, no measured height properly fitted to the minimum RSs. Only samples 6 and 8 representing 13.3% of the total measured dimensions are closed to the minimum standards having the least (5.9%) deviation from the minimum standard and 10.9% deviated from maximum standard.

As noted in the study, manual lifting of load such as wheels, brake drums etc. is common in motor mechanic works. Work techniques used, for instance when changing tyres, are mostly in awkward postures and/or use of excessive force. Some aspects of the trade also constrained worker to assume improper postures to execute them. This can be confirmed in plate 1 where a mechanic lifted to fix a 20kg tyre at improper posture. Such postures held for too long without a brake can attract a high risk. In Plate 2 because of the limited space, a mechanic bent forward to carry out some specific tasks. Working under bonnet may lead the wrist and arms to assume improper posture at the limit of reach. However as evidence in the result of statistical analysis, the high prevalence of low back pain among the workers might be as a result of the combined effects of manual lifting of automobile components parts and the awkward postures commonly adopted at work by workers. Studies have also revealed a relationship between low back pain and the specific motion patterns during forward bending. The reported forward bending patterns required by the job might also contribute to the high degree of low back pain among the group of workers. Measures to reduce the work-related disorders among workers became necessary. Lifting of heavy automobile components should be with use of lifting devices. For instance, wheel-carrying trolley may be used for heavy lifting and moving of wheels. Training of workers and managers, on safe lift, should also be considered. These measures will reduce the level of occurrence of job related discomforts and prevent injuries connected with it.

As observed in plate 3 and 5, most workers work through limited spaces and sometime in supine position with insufficient clearance when compared with the minimum RSs set for similar tasks. Working in such a restricted space forces worker to adopt improper posture for a sustained period. This might lead to pains in some regions of the body and/or serious and fatal accidents. Most of the cases observed, workers work beneath vehicle that is only supported on jacks and the wheels on the ground are not securely chocked. Slip from such supports could lead to crushing or death. Other work space design which poses treat to workers' comforts is the poorly designed work benches. According to USDE [8], higher stand-up bench reduces back-strain caused by bending over lower-level surfaces and makes access to work easier. All the measured workbenches are found below the RSs. Using such workspaces forced the users to bend for the period of working. Right design of workbenches use in automobile workshop is a measure that can reduce bending at work. Safe working procedures should also be in place when working beneath vehicles; car should be raised with trolley jack and axle standing on a firm and level surface. Wheels remaining on the ground should also be properly chocked.

Some aspects of automobile mechanic works may also require kneeling position such as noted in Plate 4. Knee region may be exposed to strain. According to [15], when there is direct pressure and friction of repetitive kneeling it may result into an inflammation of the largest knee bursa (protective sack), located between the kneecap and the overlying skin. This may result into complaints of pains. Knee pains, which rank among the leading disorders reported, might be as results of kneeling on grits for prolong time to carry out some specific jobs. It will be helpful if workers are

provided with, and adopt use of, protective equipment on the knee region.

In a similar manner, there is high report of hand and/or wrist pains this might be as a result of twisting of hands and forceful gripping of automobile parts and/or working tools. Tightening wheel nuts for instance requires forceful gripping and sometimes creates strain injury. According to [16] forceful grip exertions of hand rely on muscle contractions in forearm and muscle forces are transferred to fingers via tendons. The affected workers are exposed to risks of hand and wrist related problems, such as Tendonitis - a cumulative trauma disorders which are usually caused by repeated and/or forceful exertions associated with repeatedly tensed tendon in contact with a hard surface [17]. Forceful gripping in combination with other risk factors may cause cumulative trauma disorders [18]. Padding may therefore be helpful in handling automobile working tools. The use of hand gloves in hand-gripping should also be widely encouraged among the group of workers.

4. CONCLUSIONS

This study assessed work-space and work-method designs, level of compliance with recommended standards and effects on workers' wellbeing. Arising from the major findings the following points are drawn;

1. 94.4% of the workers who participated in the study suffered from low back pain, 43.5% complained of neck pain and about 40% reported pain in their knees regions. Other reported pains affected shoulder and wrist/hands (26.6%), hips/ thighs (25.8%) and fingers (19.4%).
2. 85.6% of the workers do not visit hospital for work related pains. However 49.2% of this category used local herbs while 50.8% engaged the use of pain relievers for self-treatment.
3. The studied mechanic works were characterized with, manual lifting of component parts combined with awkward postures, forceful gripping, hand twisting, and standing for long period of time. Hence automobile mechanic workers may be prone to back pains, hand and/or wrist related pains and Cumulative Trauma Disorders.
4. With statistical hypothesis testing, awkward postures and low back pain, forceful gripping and wrist/hands pain, used hand tools and finger pains, forceful gripping and pain over thumb of wrist are all significant.
5. On the average, 43.33$\pm$7.3 cm was recorded for supine position clearance for an average motor mechanic worker working beneath vehicle with 15.03$\pm$14.3 percentage deviation from minimum RSs. The average height of all measured workbenches was 67$\pm$0.15 cm with 26.55$\pm$16.23 percentages deviations from the minimum RSs.
6. Use of mechanical devices for load lifting, provision of protective equipment, hand gloves/paddling to reduce frictional effects of forceful griping and ensuring appropriate clearances for supine workspace are the recommended measures to enhance safety and minimize injuries connected with automobile services and repair works.

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